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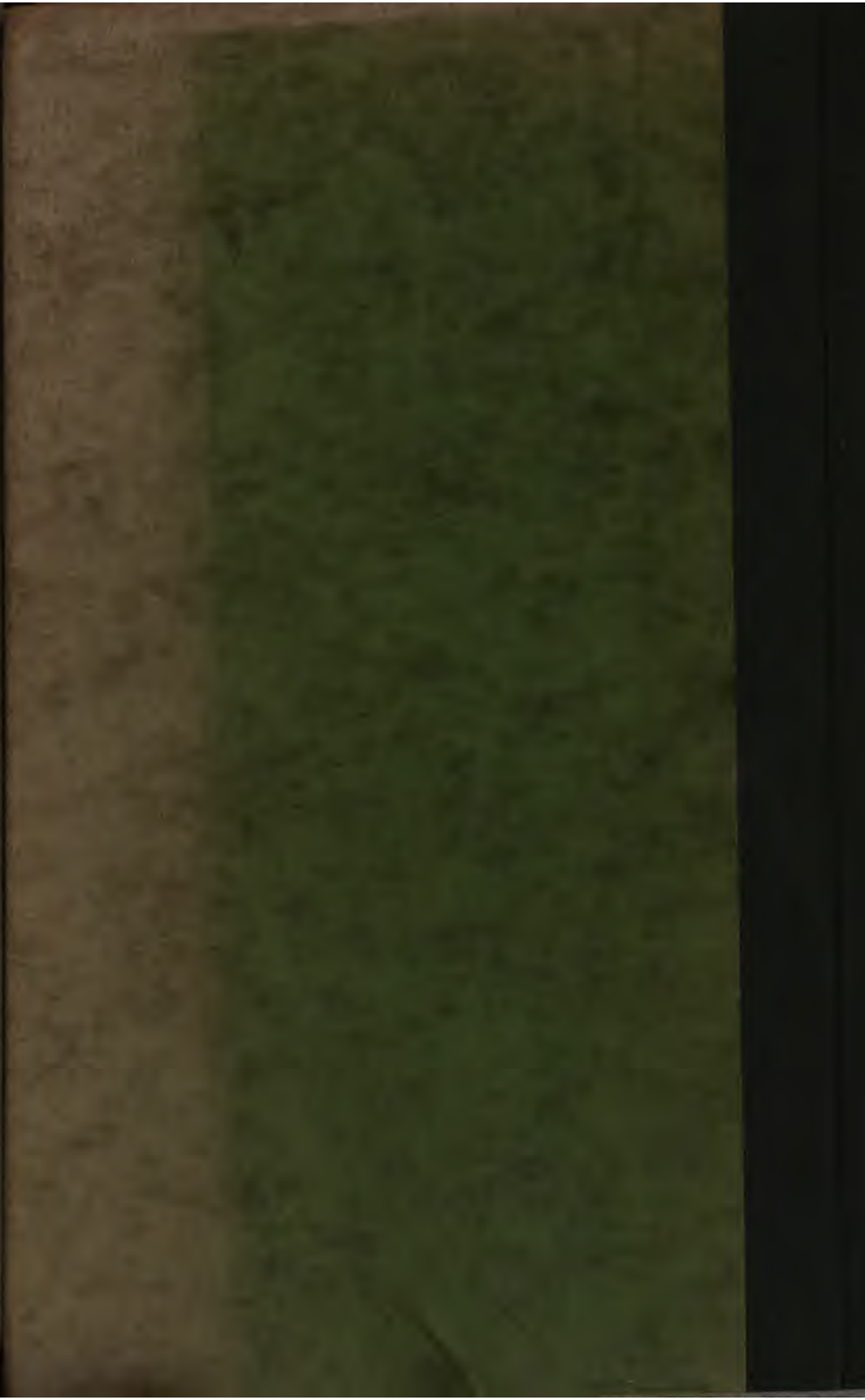
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Serial No. 161

DEPARTMENT OF COMMERCE

U. S. COAST AND GEODETIC SURVEY

E. LESTER JONES, DIRECTOR

TERRESTRIAL MAGNETISM

RESULTS OF MAGNETIC OBSERVATIONS
MADE BY THE UNITED STATES COAST
AND GEODETIC SURVEY
IN 1920

By

DANIEL L. HAZARD

Assistant Chief, Division of Terrestrial Magnetism

Special Publication No. 72



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CONTENTS.

	Page.
Introduction.....	3
Distribution of stations.....	3
Secular change of the magnetic declination.....	4
Instrumental corrections.....	4
Diurnal variation correction.....	5
Arrangement of table.....	5
Magnetic observations, table of results.....	6
Descriptions of stations:	
Florida.....	8
New Mexico.....	9
Porto Rico.....	9
Virgin Islands.....	10
Foreign countries.....	10



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RESULTS OF MAGNETIC OBSERVATIONS MADE BY THE U. S. COAST AND GEODETIC SURVEY IN 1920.

By DANIEL L. HAZARD, *Assistant Chief, Division of Terrestrial Magnetism.*

INTRODUCTION.

In 1882 the results of magnetic observations made by this Bureau prior to 1881, together with descriptions of stations, were published as Appendix 9, Report for 1881. From that time to 1902 the results were published only in connection with a discussion of the distribution or secular change of one or more of the three magnetic elements. In Magnetic Declination Tables and Isogonic Charts for 1902 the declination results were given for all the stations occupied up to that time, and descriptions were given of the stations occupied subsequent to 1881. From 1903 to 1911 there was published annually an appendix to the Superintendent's report giving the results of magnetic observations made during the fiscal year (July to June) covered by the report.

When in 1912 it was decided to confine the annual report of the Superintendent to administrative matters and to publish separately the scientific results which had formerly appeared as appendixes to the report, the time was deemed opportune to change from the *fiscal* year to the *calendar* year in the publication of the results of magnetic observations in the field. Accordingly Special Publication No. 15 contained the results of observations made between July 1, 1911, and December 31, 1912, and the results for subsequent calendar years have appeared in Special Publications Nos. 20, 25, 36, 42, 51, 55, and 64.

Five magnetic observatories have continued in operation throughout the year: At Cheltenham, Md.; Sitka, Alaska; near Honolulu, Hawaii; on Vieques Island, P. R.; and near Tucson, Ariz. Their records have furnished the means for reducing to mean of day the values of declination obtained from the field observations. There will be found in the tables the mean values of the magnetic elements for each of the observatories for the year 1920.

DISTRIBUTION OF STATIONS.

The distribution of stations is shown in the following table. There are included the results for a number of stations in the Virgin Islands at which observations were made in 1918 and 1919, not heretofore published.

Summary of results.

State.	Localities.	Stations.	Old localities re-occupied.	Declination results.	Dip results.	Intensity results.
Alaska.....	5	6	1	7	1	2
Arizona.....	1	1	1	1	1	1
Florida.....	4	4	2	4	4	4
Hawaii.....	1	1	1	2	1	2
Maryland.....	1	1	1	3	3	3
New Mexico.....	1	1	0	1	1	1
Porto Rico.....	3	3	3	4	4	4
Virgin Islands.....	11	11	2	11	1	1
Foreign countries.....	5	6	3	5	6	6
Total.....	32	34	13	38	22	24

SECULAR CHANGE OF THE MAGNETIC DECLINATION.

A comparison of the declination results at "repeat" stations occupied during the year with the results of earlier observations in the same localities is presented in the following table. The letter after the name of the station indicates (a) that the old station was reoccupied exactly and (b) that the new station was very near the old one. A tabular value of the annual change refers approximately to the middle of the period from which it was derived. A plus sign indicates increasing east declination or decreasing west declination; a minus sign, the reverse.

Comparison of declination results at repeat stations.

State and station.	Former observations.		Last observations.		Average annual change.
	Date.	Declination.	Date.	Declination.	
Maryland: Cheltenham Observatory (a).....	1918, year...	6 12.4 W..	1920, year...	6 18.4 W..	-3.0
Florida: Key West (a).....	1915, Mh....	2 30.6 W..	1920, My....	2 58.0 W..	1 d.
Cuba:					
Habana, villa (a).....	1911, Au....	3 03.0 E..	1920, My....	3 23.4 E..	+2.3
Habana, Las Cabanas (b).....	1911, Au....	3 04.0 E..	1920, My....	3 23.6 E..	+2.2
Santiago (a).....	1909, Ja....	1 40.6 E*.	1920, My....	1 00.6 E..	-3.5
Porto Rico:					
Vieques Observatory (a).....	1918, year...	3 24.0 W..	1920, year...	3 46.2 W..	-6.1
San Juan (a).....	1916, Se....	3 07.7 W..	1920, Je....	3 32.0 W..	-6.5
Mayaguez (b).....	1911, Jy....	2 08.4 W..	1920, Je....	3 14.3 W..	-7.4
Virgin Islands:					
St. Thomas (a).....	1905, My....	1 47.7 W*	1920, Je....	3 59.7 W..	-8.7
Christiansted (a).....	1905, Je....	2 16.9 W*	1919, No....	4 20.5 W..	-8.6
Arizona: Tucson Observatory (a).....	1918, year...	13 47.1 E..	1920, year...	13 48.0 E..	+0.5
Alaska: Sitka Observatory (a).....	1918, year...	30 24.9 E..	1920, year...	30 28.5 E..	+1.8
Hawaii: Honolulu Observatory (a).....	1918, year...	9 48.5 E..	1920, year...	9 53.1 E..	+2.3

* Observations by Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

INSTRUMENTAL CORRECTIONS.

Magnetometer No. 19 and dip circle No. 56 were compared with the instruments at Cheltenham at the beginning and end of the season and with the instruments at Vieques at the close of the field work. The results with the dip circle indicate a change of correction with change of dip, and the field results have been corrected on that

basis. Magnetometer No. 40 was compared with the Honolulu and Sitka instruments and will be compared with the Cheltenham instruments early in 1921.

Beginning with 1913 the results of horizontal intensity observations made by the Coast and Geodetic Survey have been reduced to the international standard of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The published results of horizontal intensity determinations made before that year must be diminished by 0.001 H to reduce them to that standard.

The instrumental corrections indicated in the tables below have been applied.

Corrections to magnetometers.

Number.	Pattern.	Correction to east declination.	Correction to H in parts of H.
17	Coast and Geodetic Survey.....	0.0	0.0000
19	do.....	0	— .0008
26	Wild-Edelmann.....	0	— .0010
30	India Survey.....	0	.0000
31	do.....	0	— .0007
36	do.....	— .4	.0000
37	do.....	0	+ .0016
40	do.....	0	.0000

Corrections to dip circles.

Number.	Pattern.	Needles.	Correction.
56	Kew-Casella.....	1	(^a)
5678	do.....	3	(^a)
		1	—2.6
		2	—2.6

^a Observations with dip circle No. 56 at Cheltenham and Porto Rico observatories indicate a change of correction to the dip needles with change of dip. The corrections applied to the results have been derived from the formulas:

$$\begin{aligned} 1. \dots \Delta I &= -5'.3 + 0'.35 (I - 51^\circ.4) \\ 3. \dots \Delta I &= -7'.4 + 0'.28 (I - 51^\circ.4) \end{aligned}$$

DIURNAL VARIATION CORRECTION.

Each value of the magnetic declination has been corrected for diurnal variation with the aid of the continuous observations at the nearest magnetic observatory, allowance being made for the change in diurnal range with change in magnetic latitude. No attempt has been made to correct the dip and intensity results for diurnal variation.

ARRANGEMENT OF TABLE.

The results presented are arranged by States alphabetically, and the results for each State are given in the order of increasing latitudes. The latitudes and longitudes are in most cases the results of solar observations made with the small theodolite which forms a part of the magnetometer. In default of observations, a chart, or topo-

graphic sheet of the United States Geological Survey, the geographic coordinates were scaled from the best available map, usually a post-route map. In such cases only the nearest whole minute of latitude or longitude is given. The horizontal intensity is expressed in terms of the one hundred-thousandth part of a C. G. S. unit of intensity of magnetic force, termed a "gamma," and designated by the Greek letter γ .

In order to include the desired amount of information in the available space, the months have been abbreviated as follows:

January, Ja.	May, My.	September, Se.
February, Fe.	June, Je.	October, Oc.
March, Mh.	July, Jy.	November, No.
April, Ap.	August, Au.	December, De.

The numbers shown as a decimal in the column headed "D. C." give the needles used. Dip circle No. 5678 is designated as 78 in the table.

The observer is indicated by the initials of his name. The names of the observers are as follows:

G. L. Bean.	George Hartnell.	F. L. Peacock.
E. C. Bennett.	W. M. Hill.	O. W. Swainson.
W. H. Cullum.	H. E. McComb.	F. P. Ulrich.
S. A. Deel.	W. W. Merrymon.	A. C. Witherspoon.

Magnetic observations on land.

ALASKA.

Station.	Latitude.	Longitude.	Date.	Declination.	Dip.	Horizontal intensity.	Instruments.		Observer.
							M.	D. C.	
	° ' "	° ' "		East.	° ' "	γ			
Kor.....	54 41.8	132 04.4	Se. 25	28 25	.. ....	.....	743	.....	F. L. P.
End.....	54 42.0	132 05.3	Se. 22	30 12	.. ....	.....	743	.....	G. L. B.
Stone Rock.....	54 44.5	131 58.1	Oc. 2	29 00	.. ....	.....	743	.....	E. C. B.
Orca, ecc. 1.....	54 48.1	131 57.1	Oc. 18	29 34	.. ....	.....	743	.....	G. L. B.
Orca, ecc. 2.....	54 48.1	131 57.1	Oc. 18	27 15	.. ....	.....	743	.....	G. L. B.
Sitka Observatory...	57 03.0	135 20.1	Year	30 28.5	74 22.2	15568	37	2 EI	F. P. U.
Do.....	57 03.0	135 20.1	No. 3-5	30 28.7	.. ....	15576	40	.....	F. P. U.

ARIZONA.

Tucson Observatory.	32 14.8	110 50.1	Year	13 48.0	59 28.0	26880	30	3 EI	W. H. C.
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FLORIDA.

Key West.....	24 33.7	81 47.6	My. 3	2 58.0	56 37.6	27743	19	56.13	W. W. M.
Fort Lauderdale.....	26 07.2	80 07.0	Ap. 27	1 34.6	58 36.3	26992	19	56.13	W. W. M.
Bunnell.....	29 27.4	81 15.6	Ap. 23	1 07.6	62 03.6	25028	19	56.13	W. W. M.
Jacksonville.....	30 22.2	81 39.9	Ap. 19	1 04.1	63 02.0	24581	19	56.13	W. W. M.

HAWAII.

Honolulu Obs'y.....	21 19.2	158 03.8	Year	9 53.1	39 25.5	28838	36	4 EI	H. E. McC.
Do.....	21 19.2	158 03.8	My. 22-30	9 53.3	.. ....	28851	40	.....	H. E. McC.

Magnetic observations on land—Continued.

MARYLAND.

Station.	Latitude.	Longitude.	Date.	Declination.	Dip.	Horizontal intensity.	Instruments.		Observer.
							M.	D. C.	
Cheltenham Obs'y...	38 44.0	76 50.5	Year	<i>West.</i> 6 18.4	70 55.7	19114	26	26 EI	G. H.
Do.....	38 44.0	76 50.5	Ja.-Fe.	6 17.3	70 54.1	19121	19	56.13	G. H.
Do.....	38 44.0	76 50.5	Au. 23-26	6 19.1	70 57.9	19096	19	56.13	G. H.

NEW MEXICO.

State College.....	32 17.3	106 44.3	Au. 30, 31	<i>East.</i> 13 06.3	60 07.4	26599	17	78.12	S. A. D.
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PORTO RICO.

Porto Rico Obs'y....	18 08.8	65 26.9	Year	<i>West.</i> 3 46.2	51 23.2	27822	31	1 EI	W. W. M.
Do.....	18 08.8	65 26.9	Je.-Jy.	3 46.4	51 22.0	27856	19	56.13	W. W. M.
Mayaguez.....	18 13.8	67 10.4	Je. 14	3 14.3	50 45.0	28325	19	56.13	W. W. M.
San Juan.....	18 27.2	66 08.3	Je. 10	3 32.0	52 07.4	27768	19	56.13	W. W. M.

VIRGIN ISLANDS.

Christiansted.....	17 44.3	64 41	1919. No. 12	4 20.5	.. ..	.....	6	.....	A. C. W.
Nicholas.....	17 45.3	64 52.7	1920. Mh. 9	4 07.3	.. ..	.....	7	.....	O. W. S.
Salt.....	17 47.0	64 45.0	Fe. 26	3 16.0	.. ..	.....	7	.....	O. W. S.
Saba.....	18 18.4	65 00.1	Mh. 22	4 18.0	.. ..	.....	7	.....	O. W. S.
Green.....	18 18.7	64 54.5	Mh. 22	4 05.1	.. ..	.....	7	.....	O. W. S.
Norman (B. W. I.)...	18 18.9	64 36.9	1919. Ja. 21	3 26.6	.. ..	.....	6	.....	O. W. S.
May.....	18 19.8	64 48.4	1918. Au. 12	4 56.0	.. ..	.....	6	.....	O. W. S.
Flag.....	18 19.9	64 54.7	Je. 10	4 15.9	.. ..	.....	6	.....	O. W. S.
St. Thomas.....	18 20.5	64 54.9	1920. Je. 5	3 59.7	51 28.2	28078	19	56.13	W. W. M.
East End.....	18 20.8	64 40.4	1919. Ja. 22	5 07.7	.. ..	.....	6	.....	O. W. S.
Mary.....	18 22.4	64 44.9	1918. No. 13	4 02.7	6	O. W. S.

DOMINICAN REPUBLIC.

Porta Plata.....	19 49	70 41	My. 31	52 45.9	28246	19	56.1	W. W. M.
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HAITI.

Port au Prince.....	18 33.0	72 20.3	My. 29	0 21.4	50 39.3	29051	19	56.1	W. W. M.
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CUBA.

Guantanamo Bay...	19 55.9	75 08.9	My. 26	<i>East.</i> 0 08.8	52 54.7	28434	19	56.13	W. W. M.
Santiago.....	20 00.8	75 43.0	My. 23	1 00.6	52 40.0	28621	19	56.13	W. W. M.
Habana, Villa.....	23 06.6	82 21.2	My. 18	3 23.4	54 45.8	28664	19	56.13	W. W. M.
Habana, Las Cabanas	23 09.4	82 20.6	My. 17	3 23.6	55 02.4	28455	19	56.13	W. W. M.

DESCRIPTIONS OF STATIONS.

Magnetic observers are instructed to mark each station (except auxiliary stations for development of local disturbance) in as permanent a manner as possible, either with a stone, a draitile filled with cement, or a post of some durable wood, so that it may be available for future occupation. They are also required to furnish a sufficiently detailed description to locate the station, even if the marking should be destroyed, and to determine the bearings of two or three prominent objects in addition to the one used as a reference mark in the azimuth and declination observations. The information is given in abridged form on the following pages. Further details can usually be obtained upon application to the Director of the Coast and Geodetic Survey.

The usual method of marking a station is by a stone post about 30 inches long and 6 inches square, set so as to project 2 or 3 inches above the ground. In the center of the top is set a circular bronze plate $3\frac{1}{2}$ inches in diameter.

When the local authorities desire it, and are willing to bear the expense, a second stone is set to mark the true meridian.

The descriptions of stations are arranged alphabetically by States and by names of stations.

FLORIDA.

Bunnell, Flagler County.—The magnetic station is near the southeast side of the extension of Lambert Avenue, at a point about 700 feet southwest of the railroad. It is about 70 feet southwest of a fence along the southwest side of an unopened street, 45 feet west-southwest of a pine tree, and 25.5 feet west-northwest of another pine tree. It is marked by a concrete post, 8 by 8 by 32 inches, projecting about 5 inches above the ground and having a bronze disk set in the top. The following true bearings were determined:

Tip on water tower (mark).....	83 15.0 E. of N.
Methodist Church steeple.....	35 37.0 E. of N.
Center of hotel chimney.....	42 04.4 E. of N.
Near edge of brick block about 700 feet away.....	65 37.4 E. of N.
Near edge of rear chimney on brick store.....	73 53.2 E. of N.

Fort Lauderdale, Broward County.—The station is in the southeast part of the city park, about one-fourth mile northeast of the depot. It is about 67 feet north of the center of Park Avenue and about 99 feet west of the center of Osceola Street, 92.6 feet east-southeast from the southeast corner of the woman's building, and 17.3 feet northeast of a pine tree. The station is marked by an 8-inch tile filled with cement and set flush with the ground. A bronze disk is set in the top. The following true bearings were determined:

Tip on cupola of Broward Hotel (mark).....	4 40.4 W. of S.
Tip on city water tank.....	45 35.4 W. of S.
Southwest corner of woman's building.....	81 02.5 W. of N.
Southwest corner of school building.....	75 08.8 E. of S.
Near edge of tower of Baptist Church.....	38 05.6 E. of S.

Jacksonville, Duval County.—The station is on the northeast corner of the old county-prison farm, which is now the new addition to the State fair grounds, about 800 feet north-northwest from the main entrance to the grounds. The station is on the east slope of a sandy hill, 96.6 feet east of the east side of the old pesthouse which stands on the crest of the hill, 41 feet south of the north fence, and about 250 feet west of the east fence of the new addition. The station is marked by a rough, gray granite stone, 6 by 8 by 26 inches, with a small hole in the top to mark the center. The following true bearings were determined:

Weather Bureau tower on Graham Building.....	6 11.0 E. of S.
Tall brick stack at old brewery.....	37 51.1 W. of S.
Near gable on small frame house about 800 feet away, just north of store.....	56 46.4 E. of S.
Near edge of cement chimney on Brentwood School.....	14 15.5 E. of S.
Flagpole on near end of building 600 feet away.....	7 04.8 E. of S.

Key West, Monroe County.—The station of 1915 was reoccupied. It is on the grounds of the Army barracks, north of the hospital, about three-eighths mile east of the depot. In 1917 a frame annex to the hospital was built, and the results indicate that artificial local disturbance was introduced in the construction. The station is 10.1 feet east of the edge of the porch of this annex, 49.9 feet from the southeast pier, and 23.2 feet from the northeast pier, and 49 feet south of the near face of the southeast corner buttress of the concrete cistern. The station is marked by a brass plug lettered U. S. C. & G. S. set in the coral rock about 6 inches below the surface of the ground. The following true bearings were determined in 1915 and 1920:

Southeast tower of armory.....	3 26.4 E. of S.
Northwest tower of armory.....	1 26.4 E. of S.
East gable of freight house on pier.....	20 53.5 W. of N.
West gable of barracks.....	88 08.4 E. of S.
North gable of stable.....	32 04.0 E. of S.

NEW MEXICO.

State College, Dona Ana County.—The station is on the grounds of the State Agricultural College. It is on the open range east of the buildings, east of and nearly in line with the south side of Hadley Hall. It is about 30 feet west of a dry arroyo running about 200 yards east of the pump house. The location is known to Profs. Jourdan and Hagerty of the college. The station was marked by a concrete post, 6 by 8 by 30 inches, with a brass station marker set in the top. The post projects about 3 inches above the ground and is protected by a heap of sand and gravel. A similar post was set in the north meridian at a distance of 864.65 feet. The following true bearings were determined:

Flagpole on Las Cruces post office.....	41 29.0 W. of N.
Tip of Las Cruces standpipe.....	27 48.2 W. of N.
Highest tip on Organ Range.....	68 16.0 E. of N.
Tip of water tank at Prof. Hagerty's residence.....	30 29.4 W. of S.
Tower on engineering building, ball at base of pole.....	78 58.5 W. of S.

PORTO RICO.

Mayaguez.—Observations were made very near the stations of 1911 and 1916 on a small plateau called Pina Cortado about $1\frac{1}{2}$ miles north of the Playa. The station is about 58 feet from the south edge of the plateau, 30 feet from the west edge, and 42 feet from the north edge. It is 26.6 feet north-northeast of one mango tree, 34 feet north-northwest of another, and 49.6 feet west of a third. The station is marked by a

